Monitoring the Dynamics of Salmonella Prevalence in Commercial Swine Herds.

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Summary: The goal of this study was to monitor 47 commercial swine herds at slaughter to determine Salmonella prevalence over a 2 year period. Mesenteric lymph nodes were collected (n=60, pooled 5:1 for a total of 12 samples) at the time of slaughter and cultured. Tissue samples were collected from the diaphragm and tested by ELISA. After a first phase of testing, we identified 10 herds that had both low culture positives and low average ELISA OD values. We also identified 10 herds that had both a high culture positives and high average ELISA OD values. The purpose of testing during Phase II was to see if the 10 "low" herds remained low and the 10 "high" herds remained high. The findings confirm the need for an on-going monitoring for tracking the changing Salmonella prevalence of swine herds over time.

Keywords: Salmonella, Culturing, ELISA, On-going Monitoring,

Introduction: For the past 2 years, our research team has been monitoring the dynamics of Salmonella prevalence in 47 commercial swine herds. We wanted to determine whether herds had an oscillating Salmonella prevalence, or maintained either a low Salmonella prevalence or a high Salmonella prevalence. We believe this type of investigation is important for understanding herd specific Salmonella dynamics, which is the basis of any control program. The basic idea of reducing the Salmonella occurrence in the early stages of the pork production chain is to minimize the introduction of Salmonella serovars via live slaughter hogs by reducing the Salmonella load of herds identified as high-prevalence herds. It is also possible to minimize the cross-contamination of Salmonella during slaughter by separately slaughtering and processing pigs from high-prevalence herds. Both intervention measures depend on identifying the Salmonella prevalence (low, medium, high) of the herds supplying the pork chain. It is possible to estimate the Salmonella prevalence of a swine herd by either repeatedly detecting the number of pigs that harbor Salmonella in their intestinal lymph nodes, or by using and ELISA-test to identify animals that have developed antibodies to a preceding

infection with Salmonella. In this study, we used both methods in conjunction with one another for added security that we were estimating the most accurate Salmonella prevalence.

Materials and Methods: During phase I of the project, 47 farms were sampled to determine a baseline Salmonella prevalence for each farm. Two different kinds of samples were collected to determine this baseline prevalence. One of the samples collected was meat tissue from the diaphragm of the animal. This meat sample was sent to Iowa State University where the samples were frozen and then thawed. The resulting meat juice was collected and tested by ELISA. On average, between 58 and 72 individual meat samples were collected per farm. The other samples collected to determine Salmonella prevalence were mesenteric lymph nodes. The lymph nodes were pooled 5:1 meaning that 5 lymph nodes, (each lymph node is from a different animal from the same farm) were pooled together to make one sample. One of the problems with collecting lymph nodes at the slaughter plant is the possibility of a "clean" animal leaving the farm to pick up Salmonella during transport or at the plant, and then test culture positive for Salmonella although the animal left the farm Salmonella-free. That is why the ELISA test was used in conjunction with the lymph node culture to estimate the true Salmonella herd prevalence as accurately as possible.

Results:

Phase I: Salmonella Prevalence

Farm	# of Head	Salm. Elisa	# Pos.	Prev.	LN Pools	# Pos.	Prev.
1	3054	158	11	7.0%	12	2	16.7%
2	5098	206	4	1.9%	36	0	0.0%
3	3634	128	5	3.9%	12	2	16.7%
4	927	111	10	9.0%	24	1	4.2%
5	2783	124	6	4.8%	24	7	29.2%
6	1868	138	5	3.6%	24	6	25.0%
7	6542	120	1	0.8%	12	3	25.0%
8	1017	148	0	0.0%	12	1	8.3%
9	1427	107	13	12.1%	31	19	61.3%
10	6290	185	10	5.4%	24	1	4.2%
11	1867	134	4	3.0%	12	1	8.3%
12	4848	160	2	1.3%	24	6	25.0%
13	2979	118	2	1.7%	24	3	12.5%
14	914	106	4	3.8%	26	12	46.2%
15	3199	201	15	7.5%	36	15	41.7%
16	2773	150	8	5.3%	24	12	50.0%
17	4596	151	74	49.0%	24	16	66.7%
18	6041	139	3	2.2%	12	0	0.0%
19	6916	152	24	15.8%	12	0	0.0%
20	1682	214	23	10.7%	24	4	16.7%
21	1518	70	4	5.7%	12	3	25.0%
22	6174	132	4	3.0%	14	3	21.4%
23	6811	170	7	4.1%	24	9	37.5%
24	2579	155	1	0.6%	24	0	0.0%
25	5295	268	71	26.5%	24	17	70.8%
26	6738	144	25	17.4%	23	12	52.2%
27	2946	165	10	6.1%	25	14	56.0%
28	1792	136	4	2.9%	12	8	66.7%
29	120	53	2	3.8%	11	1	9.1%
30	1784	156	1	0.6%	24	5	20.8%
31	7099	147	59	40.1%	12	12	100.0%
32	6559	158	4	2.5%	25	5	20.0%
33	1312	135	55	40.7%	12	5	41.7%
34	3008	154	9	5.8%	21	2	9.5%
35	993	113	4	3.5%	24	5	20.8%
36	3429	156	111	71.2%	12	12	100.0%
37	2701	135	1	0.7%	16	0	0.0%
38	3406	151	2	1.3%	12	1	8.3%
39	522	175	30	17.1%	10	2	20.0%
40	2257	130	16	12.3%	24	5	20.8%
41	3701	118	3	2.5%	12	1	8.3%
42	623	149	2	1.3%	17	0	0.0%
43	1721	132	7	5.3%	24	9	37.5%
44	1720	148	29	19.6%	24	14	58.3%
45	3295	136	5	3.7%	12	3	25.0%
46	6775	120	7	5.8%	12	3	25.0%
47	2906	161	3	1.9%	12	0	0.0%
Totals	156239	6817	700	10.3%	903	262	29.0%

Table 1.

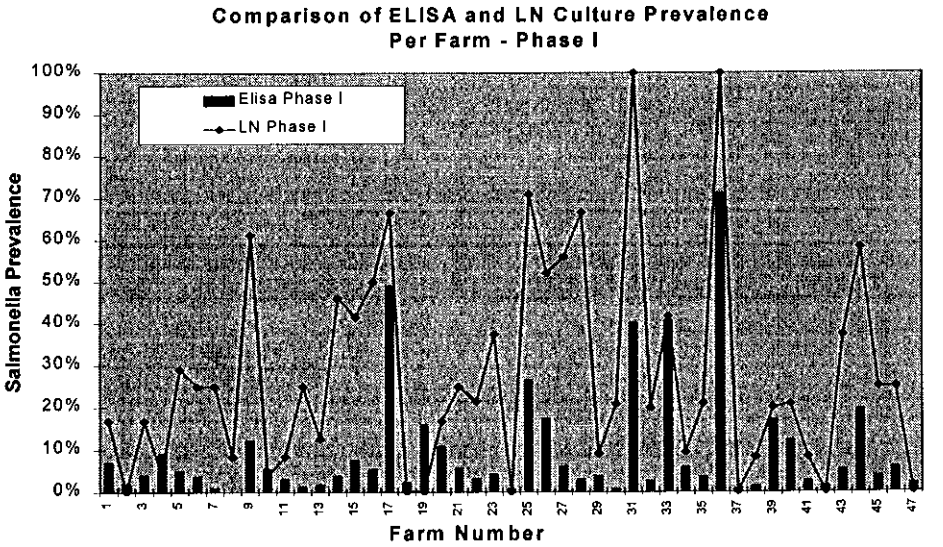
Table 2.

Phase II: Salmonella Prevalence

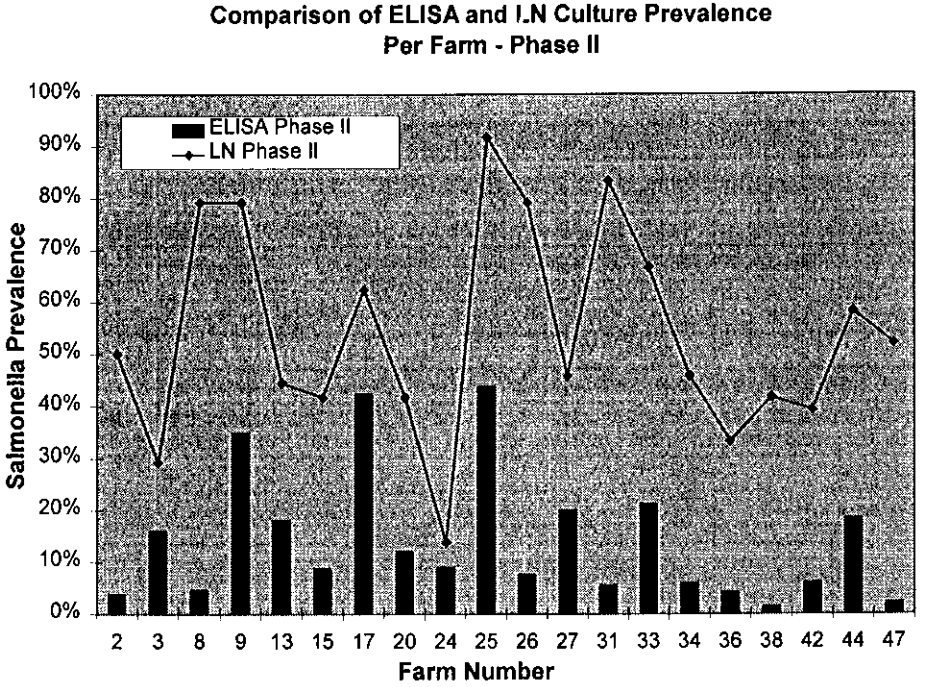
Farm	# of Head	Salm. Elisa	# Pos.	Prev.	LN Pools	# Pos.	Prev.
1	4969	0	0	0.0%	0	0	0.0%
2	3555	78	3	3.8%	24	12	50.0%
3	5126	137	22	16.1%	24	7	29.2%
4	610	0	0	0.0%	0	0	0.0%
8	3891	260	12	4.6%	48	38	79.2%
9	1719	138	48	34.8%	24	19	79.2%
11	1330	0	0	0.0%	0	0	0.0%
12	3130	0	0	0.0%	0	0	0.0%
13	6579	144	26	18.1%	36	16	44.4%
15	5341	195	17	8.7%	24	10	41.7%
17	6248	144	61	42.4%	24	15	62.5%
19	9318	0	0	0.0%	0	0	0.0%
20	4722	256	31	12.1%	48	20	41.7%
22	6891	0	0	0.0%	0	0	0.0%
24	2582	144	13	9.0%	36	5	13.9%
25	5369	144	63	43.8%	24	22	91.7%
26	7330	144	11	7.6%	24	19	79.2%
27	23,257	220	44	20.0%	48	22	45.8%
29	759	13	0	0.0%	0	0	0.0%
31	10,600	144	8	5.6%	24	20	83.3%
33	1891	156	33	21.2%	24	16	66.7%
34	3253	120	7	5.8%	24	11	45.8%
36	3432	142	6	4.2%	24	8	33.3%
37	1630	32	0	0.0%	0	0	0.0%
38	1805	70	1	1.4%	12	5	41.7%
39	2459	0	0	0.0%	0	0	0.0%
42	1500	445	27	6.1%	56	22	39.3%
43	2770	0	0	0.0%	0	0	0.0%
44	1620	136	25	18.4%	36	21	58.3%
46	3396	16	0	0.0%	0	0	0.0%
47	5775	272	6	2.2%	48	25	52.1%
Totals	**142857**	**3550**	**464**	**13.1%**	**632**	**333**	**52.7%**

Testing for phase I began in May of 1999 and continued through March of 2000. During that time a total of 6817 meat samples and 903 lymph nodes were collected at the slaughter plant. At that time, we analyzed the results that we had thus far to determine the Salmonella baseline prevalence (10.3% antibody positive meat juices, and 29.0% culture positive lymph nodes). Of the 47 farms sampled, 10 farms were identified that had both a high meat juice and lymph node culture Salmonella prevalence (9, 15, 17, 25, 26, 27, 31, 33, 36, and 44, refer to table 1). Another 10 farms were identified that had both a low meat juice and lymph node culture Salmonella prevalence (2, 8, 13, 20, 24, 34, 37, 38, 42, and 47, refer to table 1). The remaining farms had either a low/high meat juice to culture prevalence or a high/low meat juice to culture prevalence. It was decided to only continue in phase II with the 20 farms that had either a high prevalence for both of the tests, or a low prevalence for both tests. We wanted to determine if the Salmonella prevalence of each farm would change over time, or if the Salmonella prevalence would remain the same. During phase II collection (3550 meat juices, and 632 lymph nodes), most farms showed a varying prevalence over time (refer to tables 1 & 2). Graph 3 and Graph 4 demonstrate the relationship between lymph node positive and ELISA positive samples.

Graph 3.



Graph 4.



Discussion: The changing prevalence in most herds confirms the observation of most research teams investigating into the Salmonella load of swine farms. Which is that there are changes over time and that, therefore, only an on-going monitoring of repeatedly taken samples from farms to estimate a "rolling average prevalence" (e.g. every three months) as an indicator for the true prevalence (1). The well-established and successful Salmonella control programs in Denmark, Sweden and Finland use this "rolling average" for their ongoing Salmonella monitoring of their national swine herds. Graphs 1 and 2 show that there is a quite good correlation between the number of salmonella-positive lymph nodes and antibody-positive meat juices per herd. The fact that there is no 100% correlation is not due to the "weakness" of one of the two or both tests. It results from the following two biological phenomena: Pigs can be infected at a relatively early stage of production, develop antibodies, and get rid of the bacteria over time. Then, at the time of being tested, these pigs are antibody-positive, but the lymph nodes are culture-negative. Pigs can be infected at a very late stage of production, just prior to slaughter with only time enough to colonize in the lymph nodes (2). This leads to culture-positive lymph nodes, but there was too little time for developing antibodies, which results in antibody-negative meat juice. However, the

correlation is strong enough for allowing the faster and cheaper ELISA test being used as a quite good indicator for the salmonella prevalence of a swine herd provided the testing is done as an ongoing monitoring.

References:

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